



NASA'S JOURNEY TO

# MARS

Human Landing Sites Study (HLS2) Overview

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# Overview

***Sending humans to Mars is a top NASA priority and the Agency believes that such missions will significantly expand the amount of science which can be accomplished on the planet. If carefully planned and executed, the Agency sees a natural and symbiotic interdependency between robotic and human missions to Mars.***

## ***Goals of this Study:***

- Identify landing sites for human surface exploration of Mars.
  - These landing sites provide access to Exploration Zones which are regions on Mars that contain multiple sites of scientific interest as well as satisfying engineering and human constraints for human exploration
  - Leverage Mars Reconnaissance Orbiter (MRO) data collection capabilities to acquire data of potential prioritized human Mars landing sites within the exploration zones.
  - Exploration Zones will be chosen to maximize science return as well as support human operations.
  - This work will result in a database of high science interest sites, which can easily be updated as we learn more about Mars and what is needed to support humans on the planet.

This effort will be a joint HEOMD/SMD study.

The involvement of organizations such as MEPAG and the Human Spaceflight Architecture Team (HAT) is critical to ensure robust and enabling results.

- We need your ideas and creativity!





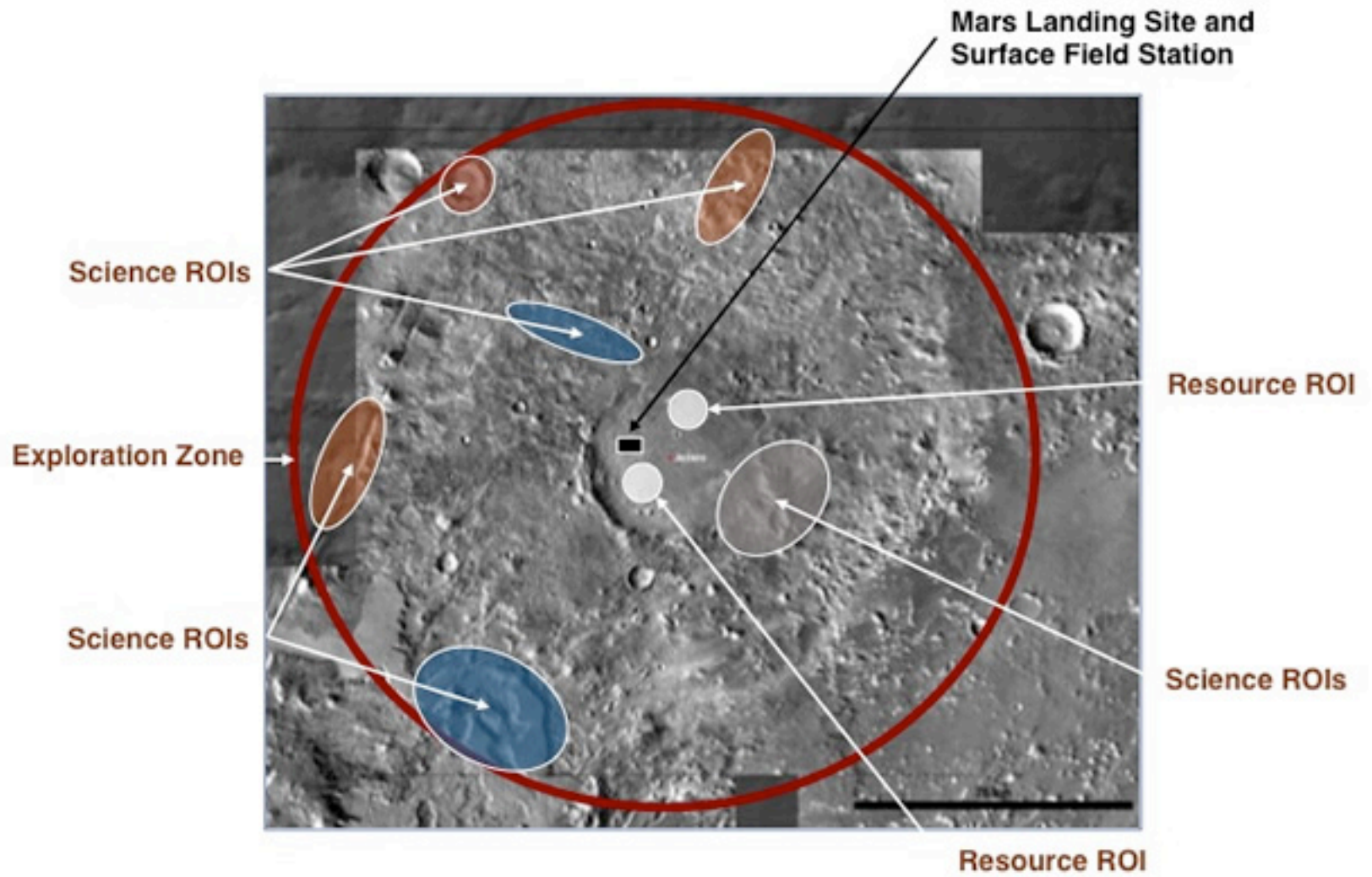
# Steering Committee

- HEOMD: Marianne Bobskill, Bret Drake, Steve Hoffman, Rob Mueller, Larry Toups
- SMD: Dave Beaty, Matt Golombek, John Grant, Lindsay Hays, Paul Niles, Rich Zurek
- Ben Bussey, Rick Davis

# Nomenclature

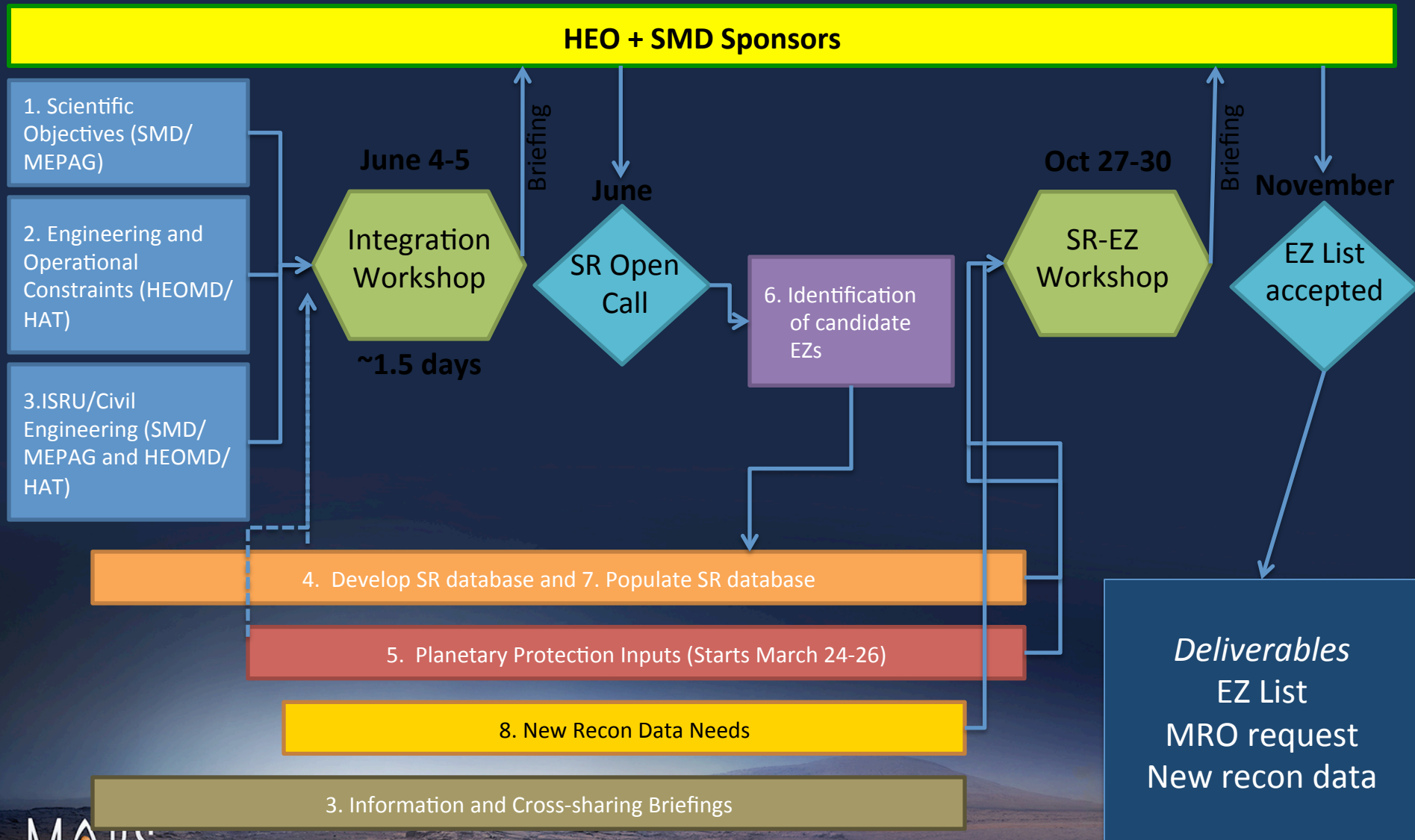
- Science Site (SS)
  - Area of high scientific interest for human exploration
- Landing Site (LS)
  - Area amenable to safe landing, given a set of EDL constraints
- Habitation Site (HS)
  - Region amenable to setting up the infrastructure required for a human mission
- Exploration Zone (EZ)
  - A region of Mars of high importance for future human exploration
  - Contains multiple SSs of different topics as well as several potential LSs, HSs and access to ISRU
  - Scale of the EZ is a function of expected crew mobility capability

# Exploration Zone Layout Considerations





# 2015 Human Landing Site Study



# Scientific Objectives

## 1. Scientific Objectives (MEPAG)

- Develop with the science community by way of MEPAG Science Analysis Group
  - Assess how humans on the surface can best be used to significantly enhanced science achieved
  - Estimate what our level of scientific knowledge will be by the time we send humans
  - Characterize and prioritize the science that will be achieved
    - Quality, diversity

# Engineering Constraints

## 2. Engineering Constraints

- EMC engineers to provide draft engineering constraints for a human landing site
  - Includes information regarding the limitations/needs of potential human surface operations



# ISRU Civil Engineering

## 3. ISRU / Civil Engineering

The ISRU and Civil Engineering Working Group (ICE WG) was tasked with developing a set of objectives that satisfy NASA's goal of a sustainable presence on Mars that is Earth independent.

Three objectives were identified

1. Demonstrate the ability to prospect and extract useful commodities from local materials
2. Demonstrate the ability to manipulate the surface for infrastructure emplacement and protection of hardware
3. Demonstrate capabilities that reduce reliance on supplies from Earth (live off the land)

# Future Reconnaissance Data Needs

## 8. Recon Data Needs

- Jointly assess what additional data is needed to support surface operations planning.
  - E.g., Mapping of regions with water
- Propose potential enhancements to imaging / data collection capabilities for future Mars observing satellites to support obtaining the needed data.

# Workshop Goals

- EZ existence proof
- Prototype EZ for imaging and analyses
- Future reconnaissance requirements
- Reference EZs for engineering analysis
- Inputs for what is needed in the AO
- Lessons learned and next steps
- Next workshop



# Workshop Statement

## Outline and Questions (1 of 3)

- EZ Concept “existence proof”
  - What is the collective opinion regarding the viability/value of the EZ concept in describing and assessing human exploration on Mars?
  - What changes should be made to the EZ criteria distributed prior to the workshop (including rationale for the change)?
  - Are there any compelling reasons to go to sites above 40 degrees latitude? Above 30 degrees latitude?
- Data Collection
  - Potential targets for the Mars Reconnaissance Orbiter (MRO) – assembled from EZ presentations (maybe prioritized but not filtered) plus group discussion
  - Ground truth – identify needs or opportunities for surface assets to collect data that can be compared to orbital data that will assist in selecting human landing site(s)
  - New data types needed (i.e., never collected before) that will assist in selecting human landing site(s) – assembled from EZ presentations plus group discussion
- Data Analyses
  - Analyses needed to improve understanding of proposed EZs – assembled from EZ presentations and used as input for proposed EZ Analysis AO
  - Non-site specific analyses of existing data (or new data as it arrives) – e.g., additional and/or refined analyses of data associated with potential regional or global distribution and concentration of resource related material

# Workshop Final Statement

## Outline and Questions (2 of 3)

- EZ selection process (i.e., this workshop, including the steps preceding it and proposed steps after, such as follow-on workshops) improvement recommendations
  - What should be kept more or less intact, what should be changed, what should be added, what should be removed, what was missed?
- Reference EZs
  - Discussion of which EZ(s) (if any) would make good “stressing cases” for assessment purposes
    - Features that envelop all of the sites (e.g., max latitude, max altitude, etc.)
    - Specific locations that can be used to test concepts of operation and/or hardware/technology options . For example:
      - A high latitude site with shallow ice potential – how would the ISRU community deal with it?
      - A hydrated mineral site – how would ISRU community deal with it?
      - Recurring Slope Lineae (RSL) site – how would the science community deal with it given planetary protection guidelines/constraints?)
- Consolidated summary of Site Selection Criteria “Rubric”
  - Assembled from all of the presentations (the “rubric” was one of the requested items in the presentation template)
- What should be the focus of the next workshop and how much time should be allowed until this workshop is held?

# Workshop Final Statement Outline and Questions (3 of 3)

- Other
  - Is an ISRU/Civil Engineering Analysis Group equivalent of MEPAG/LEAG/SBAG needed?
    - Collect rationale during group discussion
  - What other recommendations do Workshop participants have to improve / accelerate our ability to pick a human landing site / Exploration Zone?
  - Anything else that the group wants to discuss that is not covered by the previous items



# Agenda

- Tuesday Oct 27<sup>th</sup>
  - Overview talks and first working session
- Wednesday Oct 28<sup>th</sup>
  - Multiple sessions
  - Optional dinner and “The Martian” movie
- Thursday Oct 29<sup>th</sup>
  - Multiple sessions
  - Post workshop talk by Jim Green (Director PSD)
  - Evening reception
- Friday Oct 30<sup>th</sup>
  - Group Discussion